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PILOT VALVE

The present invention relates to a pilot valve, for
example of the type which is commonly used to control a

5 pressure reducing valve in water and gas supply systems.

Figure 1 illustrates the use of a "single chamber"
pilot valve 1 to control a pressure reducing valve (PRV -
shown schematically as item 2) as commonly used in a water

10 supply system. In the context of a gas supply system such
a pressure reducing valve is normally known as a
"regulator" or "governor", but herein the single term
"PRV" is used for simplicity as referring to both types of
system. The fluid to be controlled (usually water or gas,

15 and in this example will be taken to be water) flows along
the main pipe 3 through the PRV. The outlet pressure (Po)
is usually less than the inlet pressure (Pi) due to the
action of the PRV.

20 The amount of pressure reduction is controlled by
operation of the PRV under control of pilot valve 1. An
auxiliary flow pipe 4 carries water from the inlet of the
PRV to the control chamber 5 of the pilot valve 1 and then
back to the outlet of the PRV. Prior to entering the

25 control chamber 5, the water passes through a venturi
chamber (or primary orifice) 6 or, more correctly in the
context of a gas supply system, an inspirator 6 and the

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water pressure (Pv) at the outlet side 7 of the chamber or
inspirator controls the PRV.

The flow of water through the control chamber 5 is
5   controlled by a gate mechanism 8 which is linked to a
diaphragm 9. A spring 10 applies force to the rear of the
diaphragm 9 and the amount of force supplied by the spring
may be varied by an adjustment screw 11.

10   In a steady state situation (where Po remains
constant) the water pressure in the control chamber 5 will
be balanced by the force generated the spring and the gate
8 will remain in a constant position. Thus the flow
through the auxiliary pipe 4 will remain constant and PV
15   will remain constant.

If the control pressure (Po) falls, the spring 10
causes the gate 8 to open further and the flow through the
auxiliary pipe increases. Accordingly, the flow through
20   the venturi 6 also increases which results in pressure Pv
decreasing, causing the PRV to open further. This results
in the control pressure Po rising again and the system
should then reach a steady state again at the previously
set value of Po.

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In order to provide an improved control system, the
present applicant has already disclosed a system which

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uses a "dual chamber" pilot valve in European Patent No.
574241. Figure 2 shows an example of a system utilising a
"sandwich plate" dual chamber pilot 20. The pilot valve
20 performs the same general function in the control

5   system as the pilot valve of Figure 1 but in this example
the adjustment previously provided by adjustment screw 11
is effectively supplemented by an adjustment using a
control pressure (Pc). As further relevant background art
may be mentioned the gas supply pressure control apparatus

10 as disclosed by the present applicant in GB-A-2252848.

The pilot valve 20 includes a second chamber 21 which
is effectively divided into two portions 22 and 23 by a
wall 24. The control pressure Pc effectively acts against

15 the force of spring 10 by virtue of diaphragm 26. As with
Figure 1, the spring is mechanically connected by arm 28
to a gate mechanism 8 which performs the same function as
previously. The arm 28 passes through wall 24 and the
aperture through which it passes is sealed by a seal 29 so

20 that chamber 23 does not contain any water but instead is
vented to the atmosphere.

If the control pressure Pc remains constant, then the
system operates as explained with reference to Figure 1.

25 However, if the control pressure Pc is reduced then the
gate 8 will open further thereby reducing pressure Pv and
increasing the outlet pressure Po. This is usually

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referred to as a "failsafe" system since in the event that
the control pressure fails i.e. fails to zero, the outlet
pressure Po will be set to its maximum value.

5   Figure 3 illustrates an alternative but mechanically
equivalent "dual chamber" pilot valve arrangement to that
shown in Figure 2. The arrangement of Figure 3 is
sometimes referred to as a "pancake adapted" pilot. In
this arrangement, the second chamber 31 is located at the
10   base of the pilot 30. As with the arrangement of Figure
2, the second chamber 31 is divided by a diaphragm 34 into
two chambers 32 and 33 and the control pressure Pc is
applied to chamber 32. The diaphragm 34 is mechanically
linked via an arm 35 to the gate mechanism 8 but is not
15   rigidly limited to the gate or spring. The arm 35 presses
into control chamber 5 via an aperture which is again
sealed with seal 36.

        In the embodiment of Figure 3, the control pressure
20   Pc again opposes the force produced by the spring 10 and
so the control system effectively operates in an identical
manner. In other words, if control pressure Pc is reduced
then the outlet pressure Po is increased.

25   One advantage over the Figure 3 arrangement as
opposed to the Figure 2 arrangement is that the additional
chamber 31 can effectively be retrofitted to a single

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chamber pilot valve. However one disadvantage with the
dual chamber pilot valves of Figures 2 and 3 is that in
both cases a seal needs to be provided in order that the
control fluid is prevented from entering the second part
5   of the additional chamber i.e. that part of the chamber to
which the control pressure is not applied. The provision
of such a seal can be difficult and deterioration or
failure of the seal may lead to reduction in performance
of the pilot valve or leakage therefrom. Furthermore, the
10 friction caused by the seal can in turn create a
frictional error in the quality of the pilot valve
control.

Figure 4 shows a further "hydraulic" dual chamber
15 pilot valve arrangement. As with the previous
embodiments, a second chamber 40 is provided which is
divided by a diaphragm 41 into two parts 42 and 43. The
control pressure Pc is applied to part 42 of the second
chamber 40 and part 43 is connected to the spring chamber
20 which is vented to the atmosphere. As before, the
diaphragm 41 is mechanically connected to the gate 8, in
this case via the spring 10.

However, unlike the embodiments of Figure 2 and
25 Figure 3 in the embodiment of Figure 4 the control
pressure Pc acts in the same direction as the force of the
spring 10, rather than against it. This means that the

control system works in the opposite way to that of

Figures 2 and 3 i.e. if the control pressure Pc is reduced

then the gate 8 closes further, the venturi pressure Pv

increases causing the PRV to close further and the outlet

5 pressure to drop. This arrangement is not considered to

be "failsafe" since a loss of control pressure Pc would

result in the lowest possible outlet pressure Po. This is

sometimes referred to as a "direct acting" control system

rather than the "reverse acting" control systems of

10 Figures 2 and 3.

The present invention aims to provide a pilot valve

of the "reverse acting" type but which eliminates the need

for a seal.

Summary of the Invention

15 In a first aspect, the present invention provides a

pilot valve which includes

biassing means to control a gate for controlling

fluid flow through a control chamber;

20 a second chamber sealed by a second chamber diaphragm

into which control pressure is appliable for also

controlling the operation of the gate, whereby in use an

increase in control pressure acts to reduce fluid flow

through the gate;

25 wherein the side of the diaphragm against which the

control pressure is not applied is in fluid communication

with the control chamber.

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In this way, a "reverse acting" dual chamber pilot valve is provided in which the need for any seal in association with the second chamber is avoided.

5   The fluid which in use flows through the control chamber may or may not be the same fluid or type of fluid as the fluid which in use is used to apply the control pressure. The fluids in question may, for example, be water or gas. In other words, in one example both fluids

10   in question may be water; in another example both fluids may be gas; in a third example one fluid may be water and the other gas.

Preferably, the biassing means is a spring means or

15   spring such as a helical spring. Preferably the biassing means is biassed to open the gate and may be rigidly connected to the gate by a suitable mechanical linkage. Preferably the diaphragm is also rigidly connected to the gate and/or biassing means via the same or a second

20   suitable mechanical linkage.

Preferably, the control chamber is at least partly bounded by a control chamber diaphragm in addition to the second chamber diaphragm. Preferably biassing means is

25   located on the opposite side of the control chamber diaphragm to the control chamber. As will be explained in detail later in the specification, by appropriately

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selecting the areas of the second chamber diaphragm and

the control chamber diaphragm, the effect of the control

pressure on the fluid flow through the control chamber

(and therefore in use, on the outlet pressure) can be

5   selected.

In a preferred embodiment, the ratio of the area of

the control chamber diaphragm to the second chamber

diaphragm is 2:1 or less. For example, if the control

10 chamber diaphragm is twice the area of the second chamber

diaphragm then a particular drop in control pressure will

result in an identical increase in outlet pressure. In a

different example, if the area of the second chamber

diaphragm is three-quarters that of the control chamber

15 diaphragm then an increase in control pressure of a given

amount would cause the outlet pressure to decrease by

three times that amount. The particular case in which the

second chamber diaphragm area is half that of the control

chamber diaphragm effectively replicates the function of

20 the "sandwich" and "pancake" arrangements described

earlier with reference to Figures 2 and 3.

Embodiments of the present invention will now be

described by way of example with reference to the

25 accompanying drawings in which:

Figure 1 is a schematic diagram of a single chamber

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pilot valve control arrangement;

Figure 2 is a schematic diagram of a "sandwich" dual
chamber pilot valve arrangement;

Figure 3 is a schematic diagram of a "pancake" dual
5 chamber pilot valve arrangement;

Figure 4 is a schematic diagram of a "hydraulic" dual
chamber pilot valve arrangement; and

Figure 5 is a schematic diagram of a pilot valve
according to an embodiment of the present invention.

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Figure 5 shows a pilot valve 50 which includes a
control chamber 51 and a second chamber 52. A control
pressure Pc is applied to chamber 52 in use and chamber 52
is divided from control chamber 51 by a second chamber
15 diaphragm 53.

The second chamber diaphragm 53 is rigidly connected
via linkage 54 to a gate mechanism 55. The gate mechanism
55 is also connected via a further rigid linkage 56 to a
20 spring 57. The spring 57 is isolated from the control
chamber 51 by the control chamber diaphragm 58. The
action of the force of the spring 57 on the diaphragm 58
may be adjusted by adjustment screw 59.

25   As can be seen from Figure 5, the control fluid
(which may be gas or water) present in the control chamber
51 acts against the opposite side of the second chamber

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diaphragm 53 to the control pressure Pc. In operation,
if, for example, control pressure Pc is reduced then the
gate 55 will open further causing the fluid flow through
the control chamber to increase. When used in a PRV

5   control circuit, as explained previously, this will cause
the outlet pressure to increase.

As indicated in Figure 5, the area of the control
chamber diaphragm 53 is designated A and the area of the

10 second chamber diaphragm 53 is designated as A'. The
balance of forces operating in the pilot valve is as
follows:

$$SF = APo - A'Po + A'Pc$$

15 $$= (A-A')Po + A'Pc$$

In a first example, if $A' = \frac{1}{2}A$

$$SF = A'(Po + Pc)$$

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If a "multiplication" effect is required then the
relative cross-section areas can be set to a different
value. In a second example, if $A' = 3/4\ A$, the equation
will be

25 $$SF = \frac{1}{4}\ A\ (Po + 3PC)$$

Therefore an increase of Pc of a given amount would

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cause P₀ to decrease by three times the amount and vice

versa.

The above embodiment is given by way of example only

5   and variations will be apparent to those skilled in the

art.